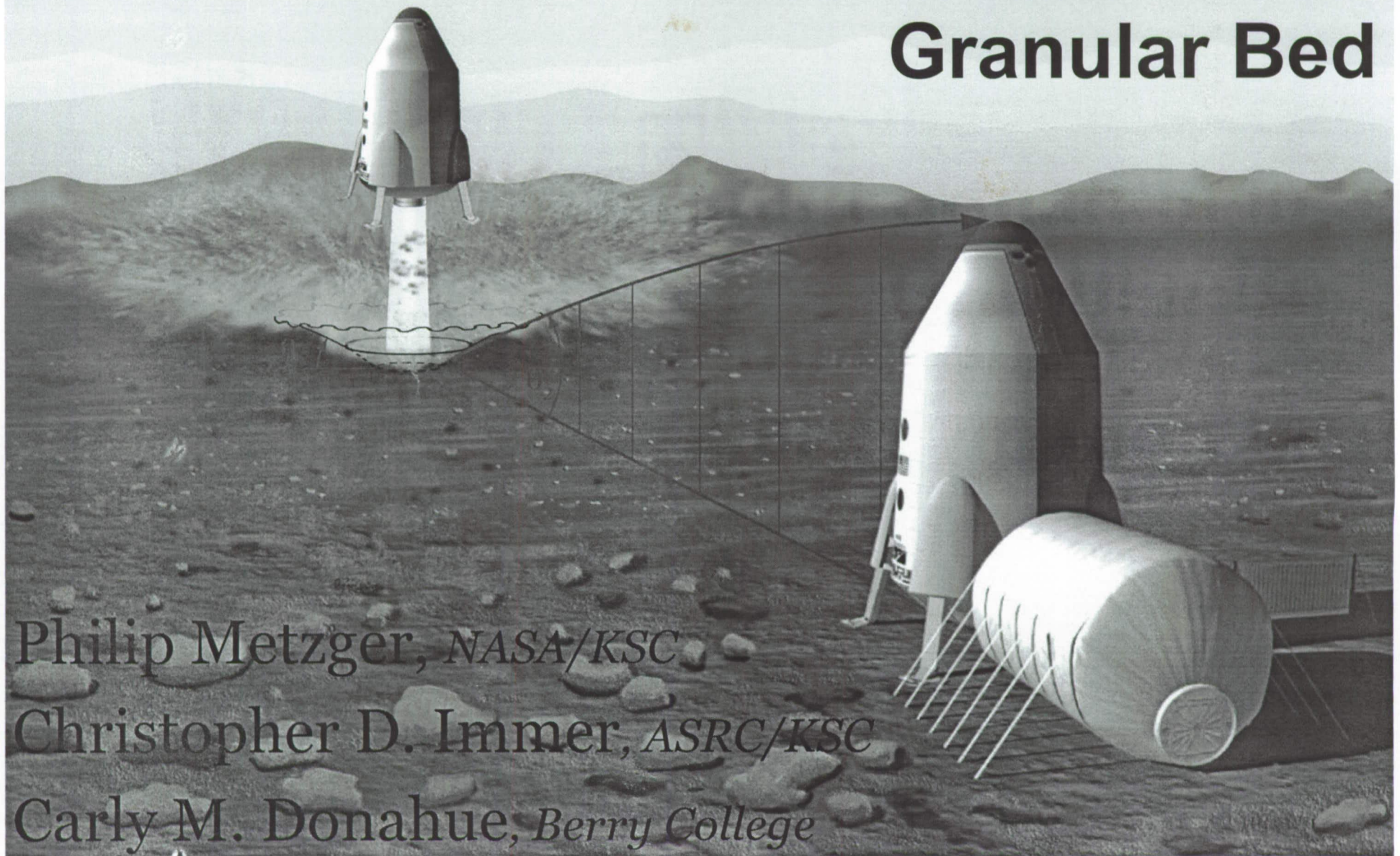


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Dynamical Scaling of Jet-Induced Crater Formation in a Granular Bed



Philip Metzger, *NASA/KSC*

Christopher D. Immer, *ASRC/KSC*

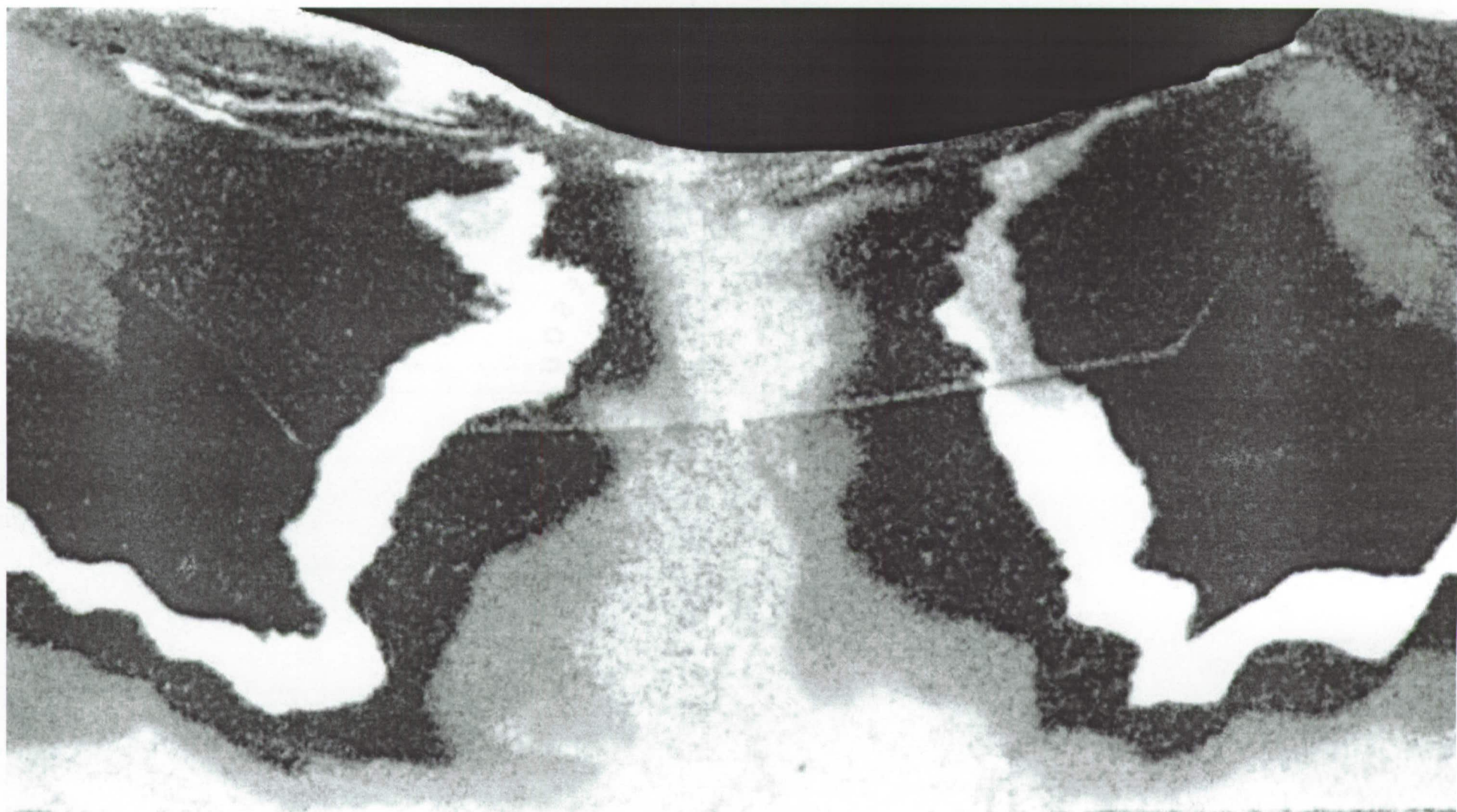
Carly M. Donahue, *Berry College*

Froude Number

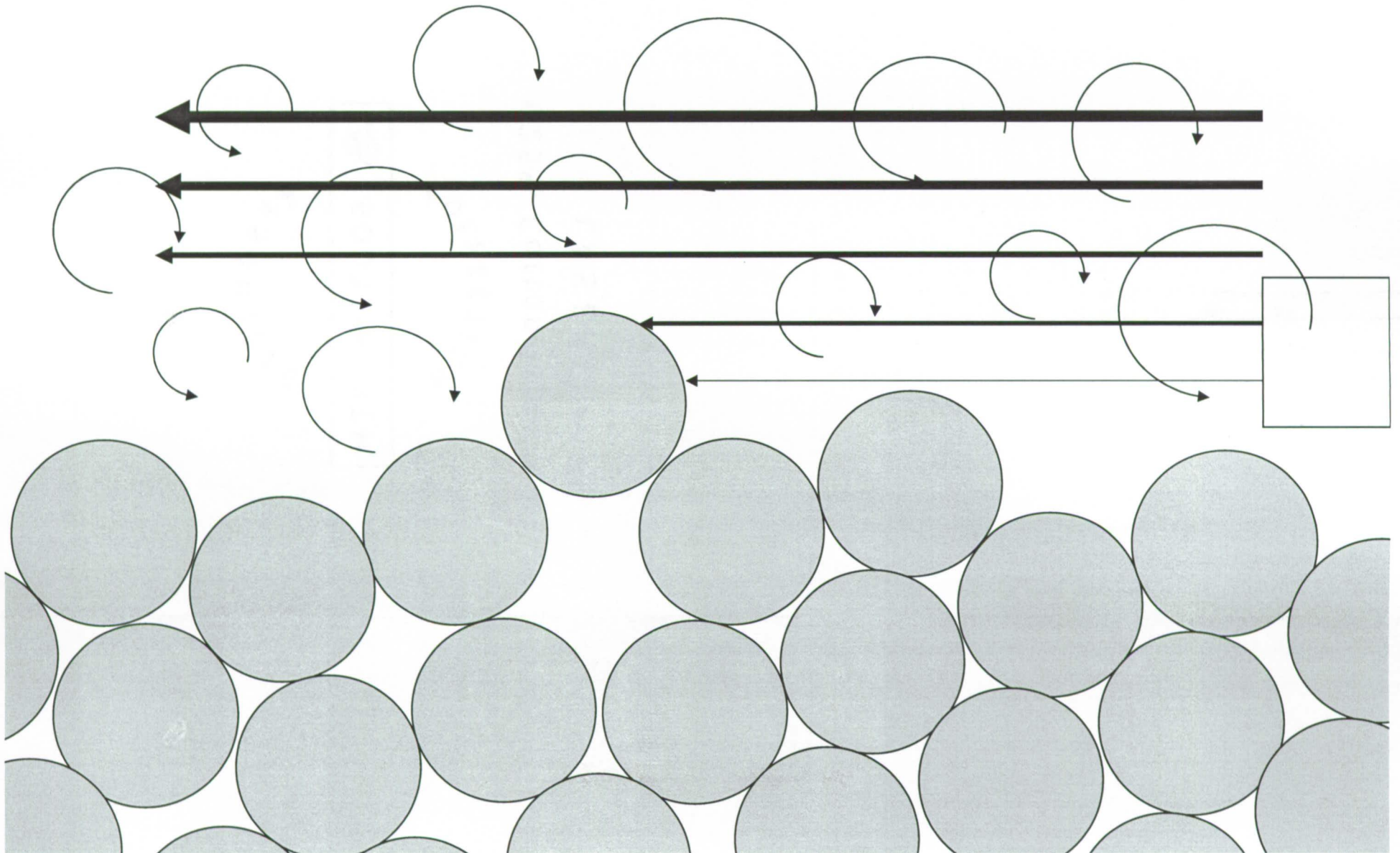
$$Fr = \frac{\rho_g V^2}{(\rho_s - \rho_g)gd}$$

Erosion Parameter

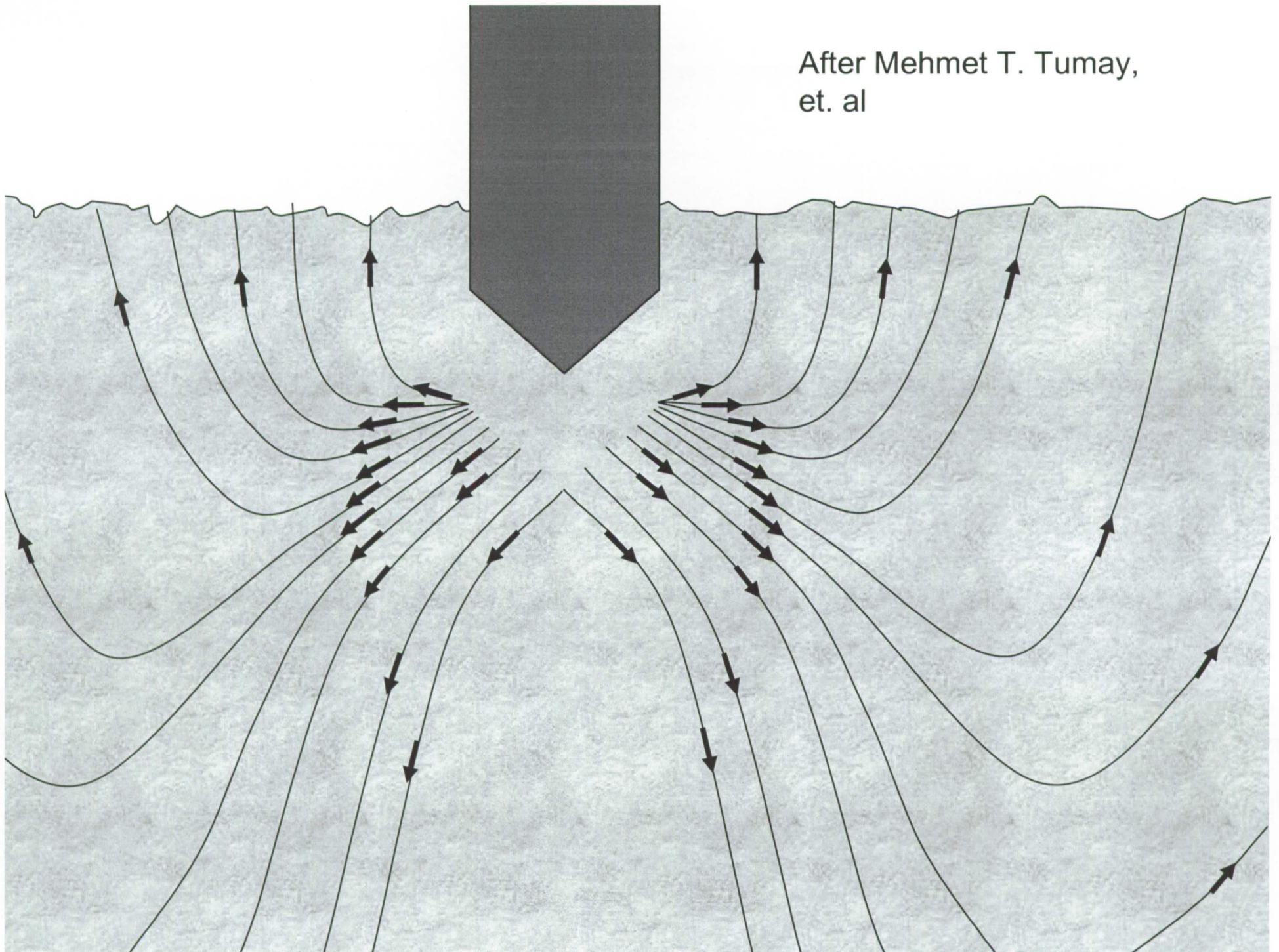
$$Ec = \frac{Fr D}{H}$$

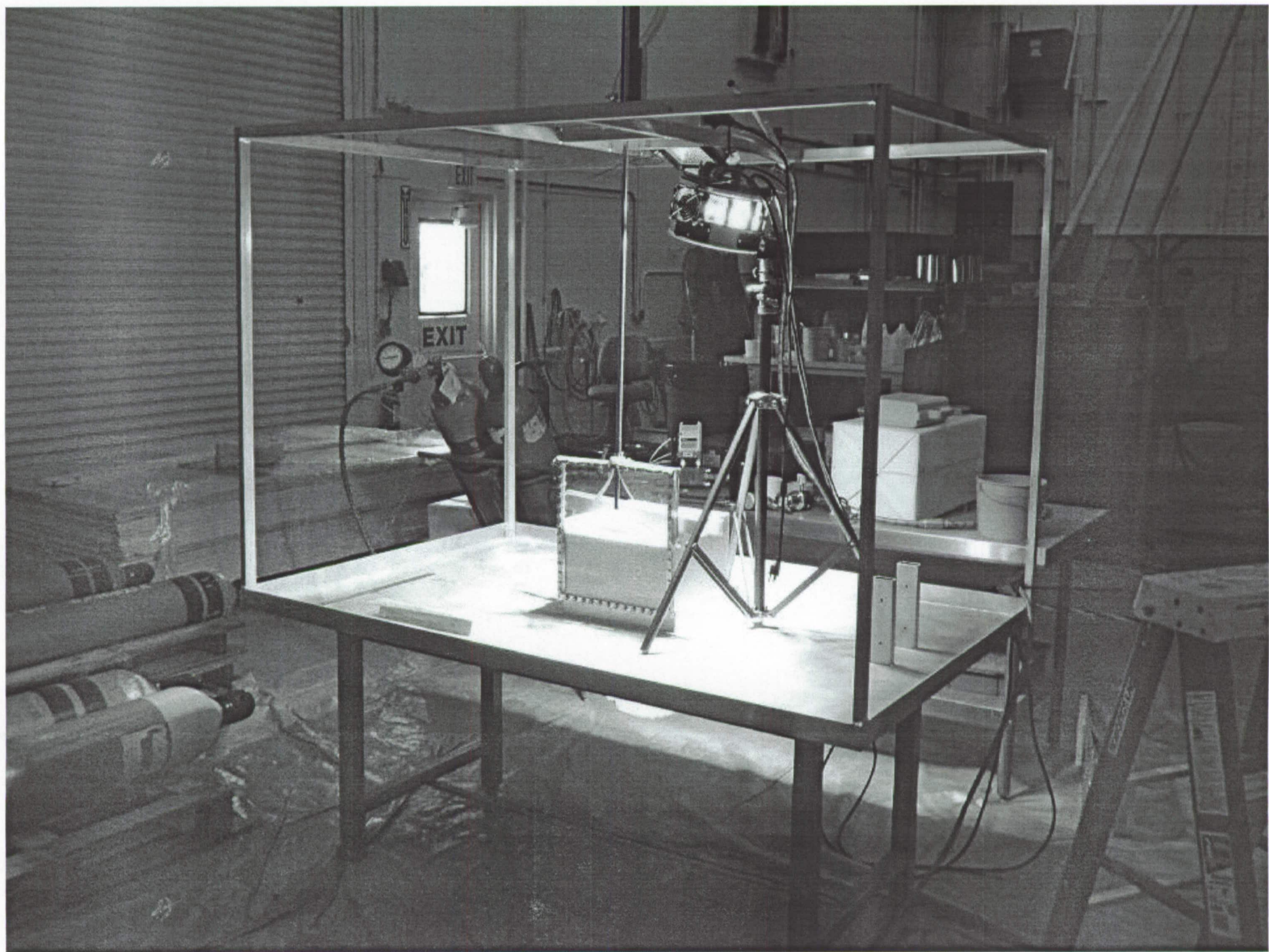


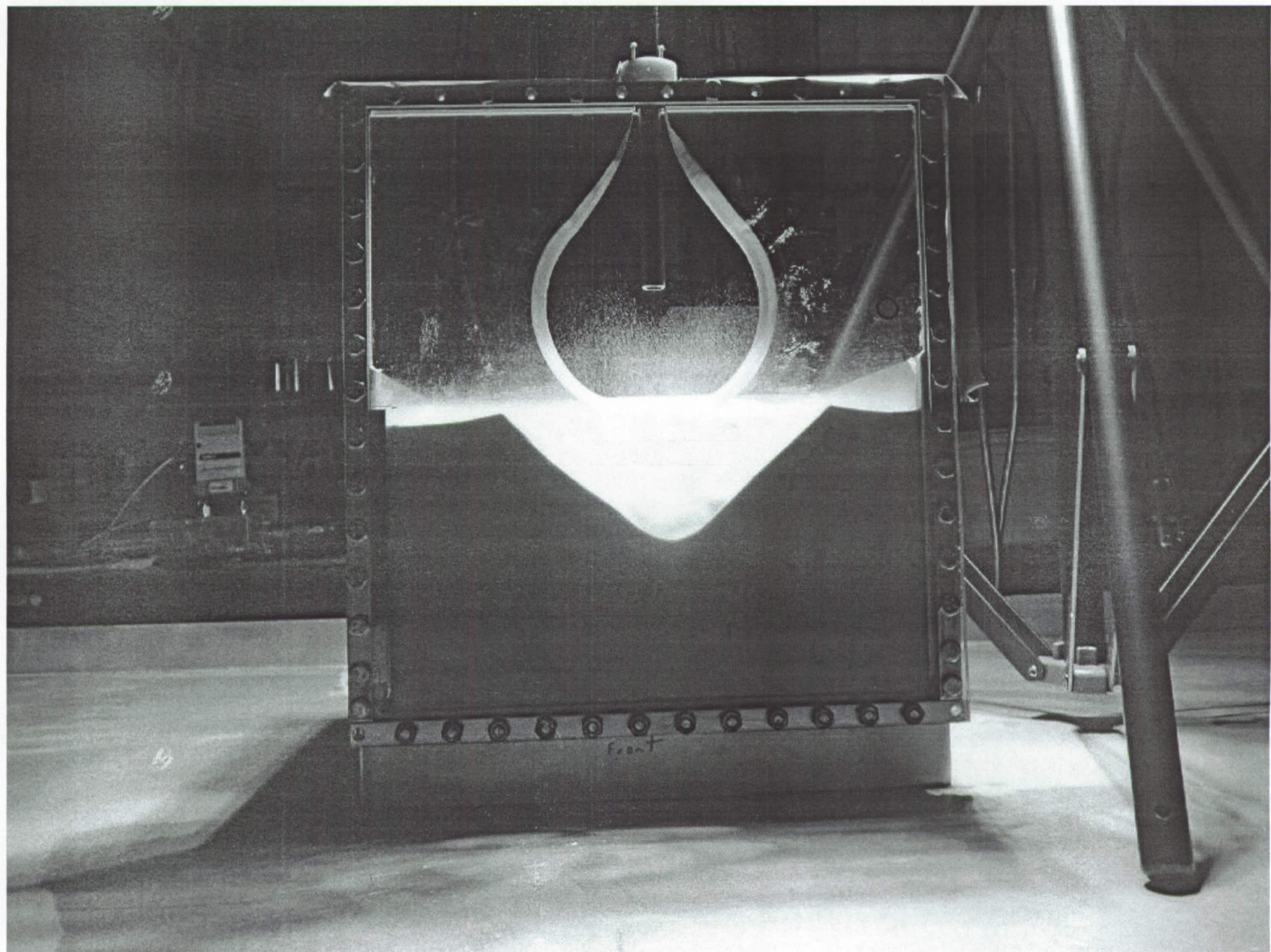
Viscous Erosion



After Mehmet T. Tümay,
et. al





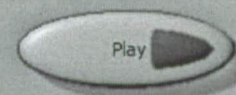
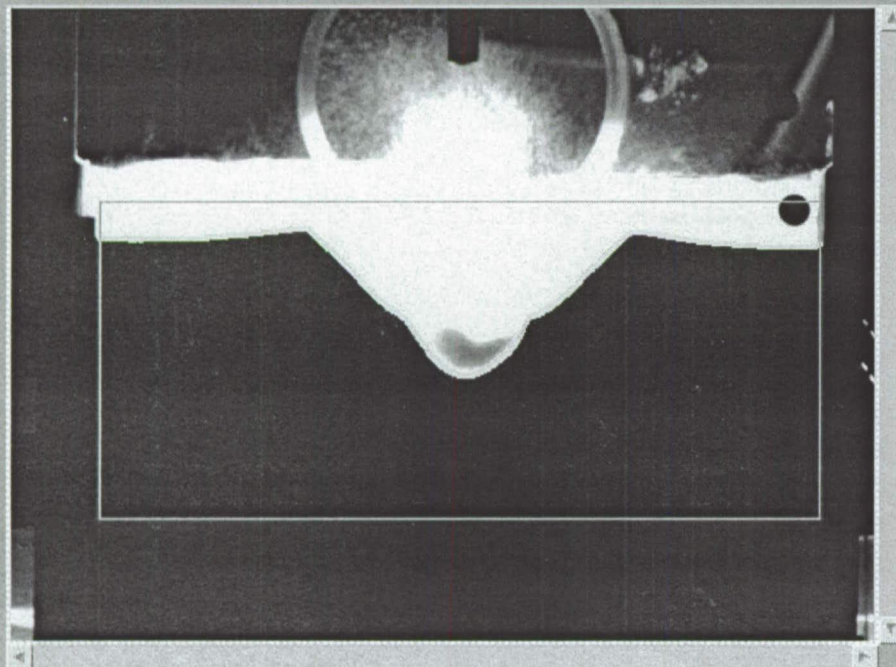
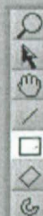
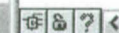


Crater Measurement.vi

available.

AVI Path

C:\Documents and Settings\USTDCAPL\My Documents\Physics of Rocket Exhaust\2005-09-09 197 LPM CO2 3in height.avi

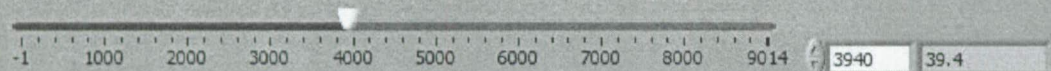


Inter-Frame Delay

100 ms

512x376 1/18-bit image 0 (508,143)

Frame



Edge Parameters

Contrast	Filter width	Steepness
40	4	0

Line Length/Circle Diameter

14 mm

Frame Rate

100 Hz

Pixel Size

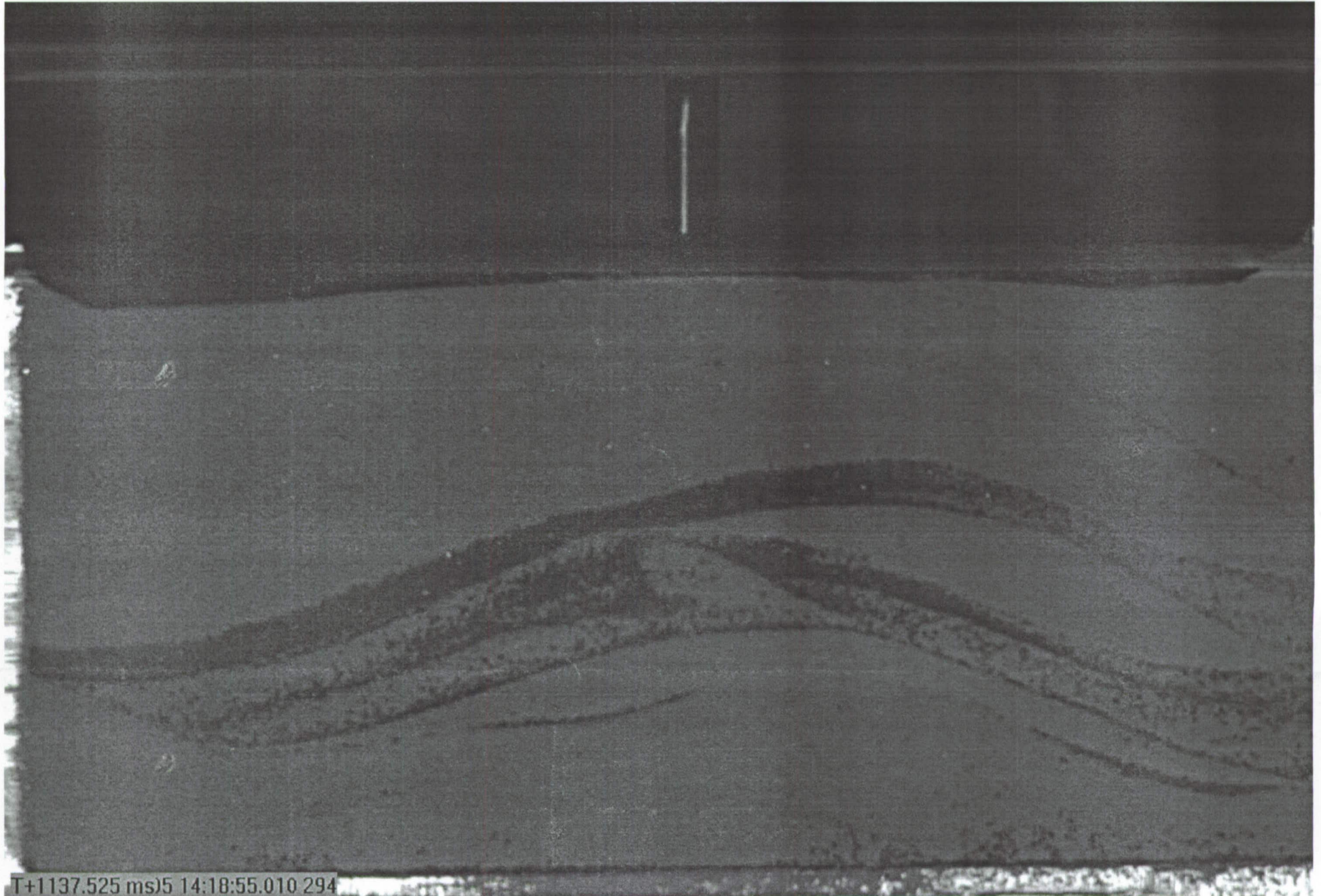
0.02744 in

Gauge Line

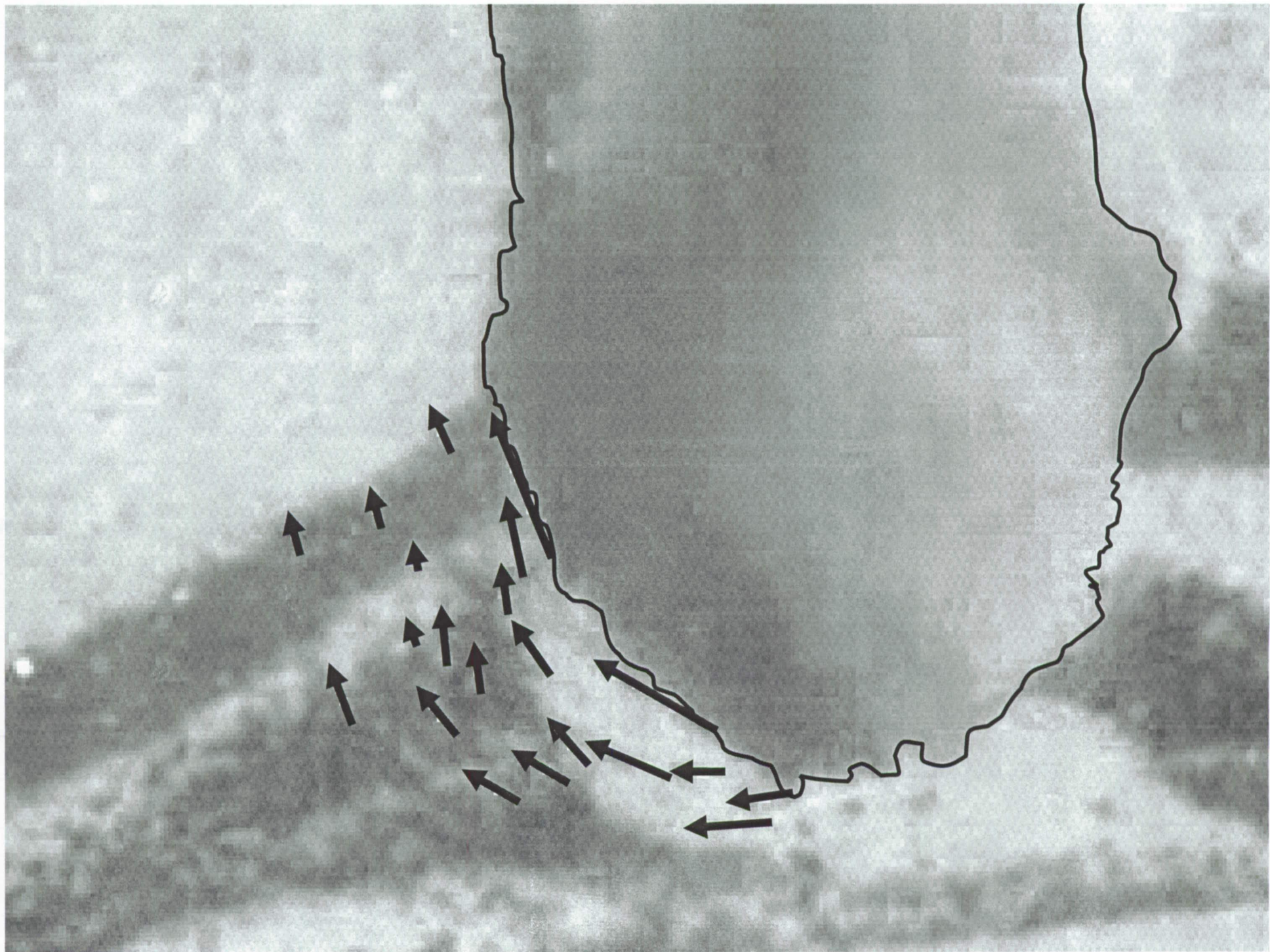
Gauge Circle

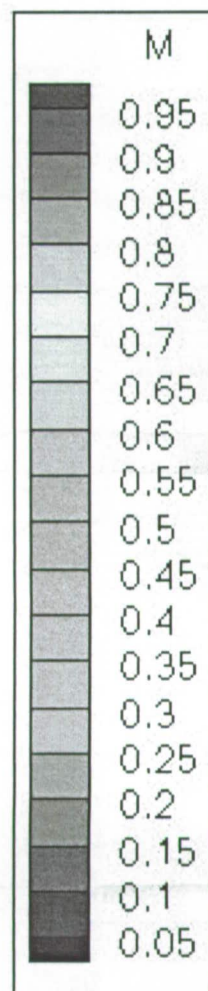
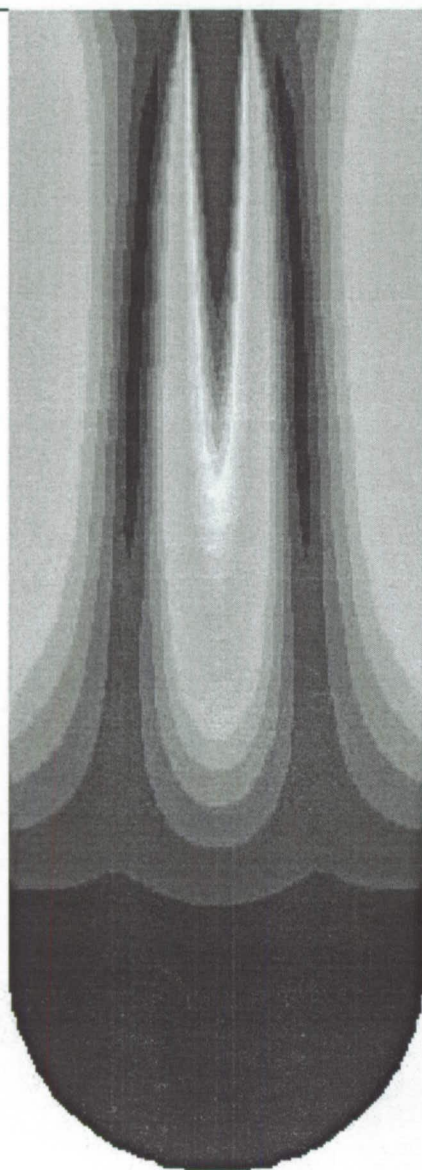
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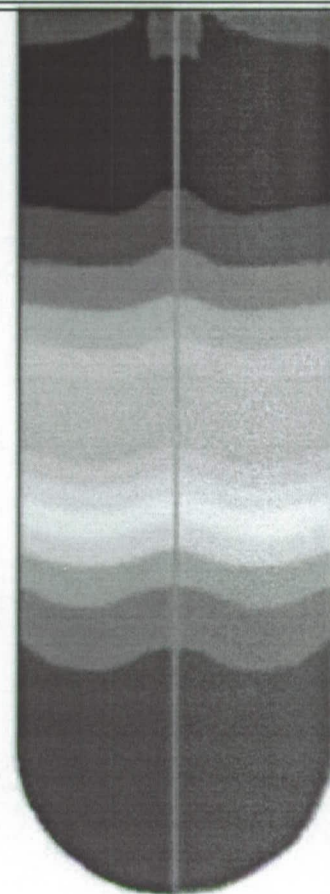
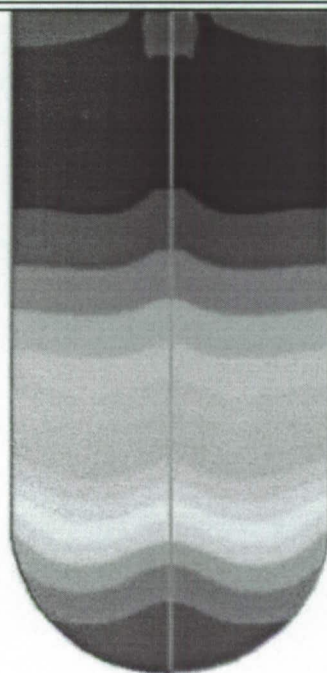
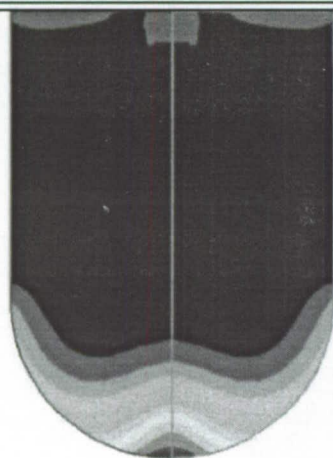
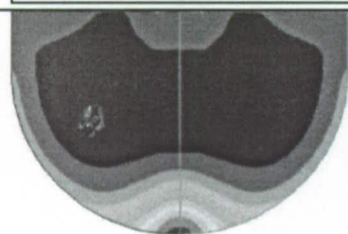
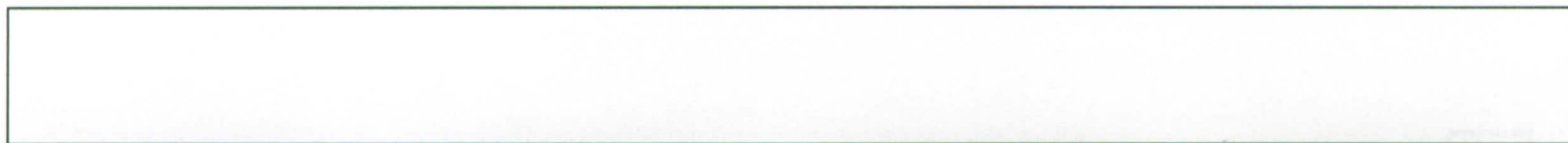
Movie of deep cratering

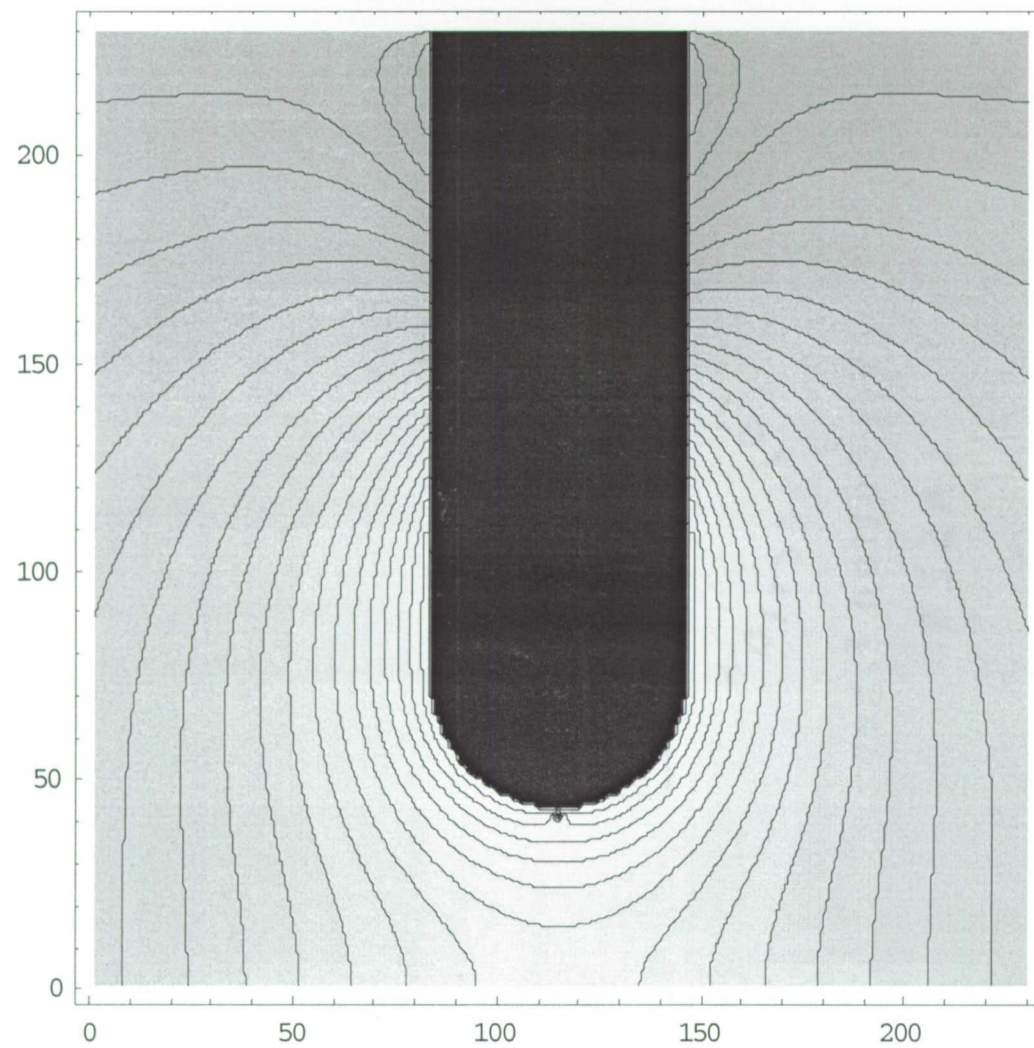


T+1137.525 ms)5 14:18:55.010 294

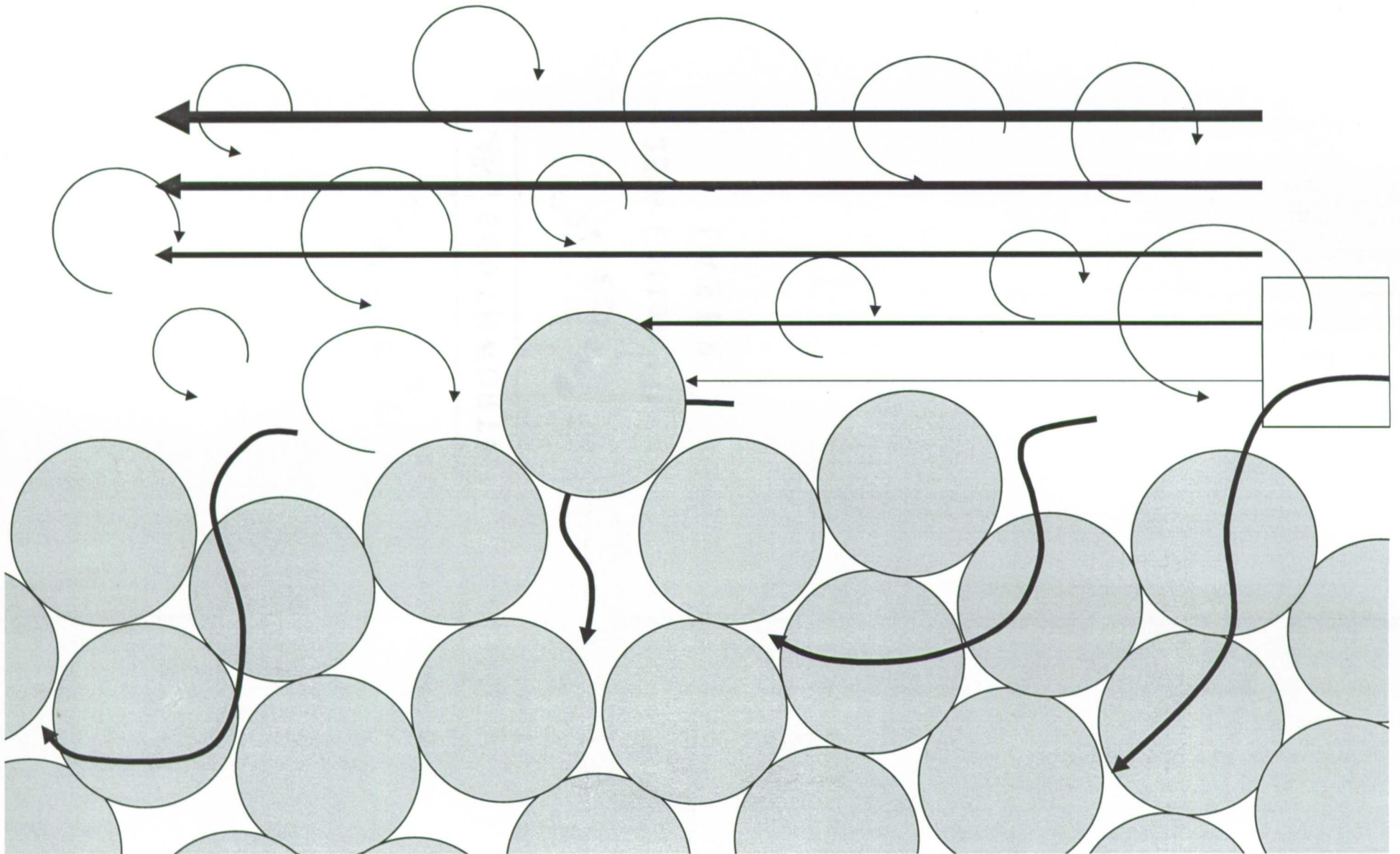




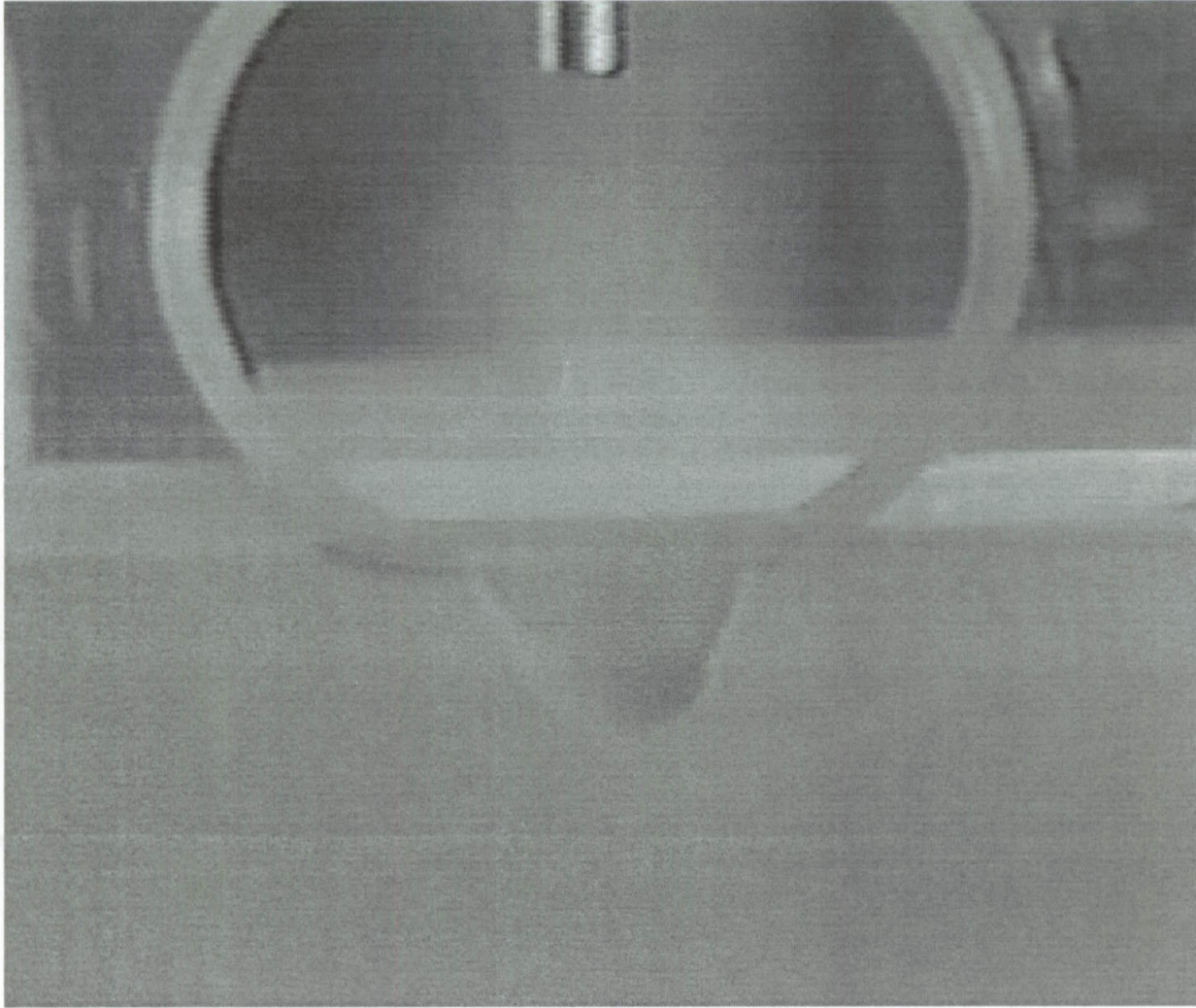


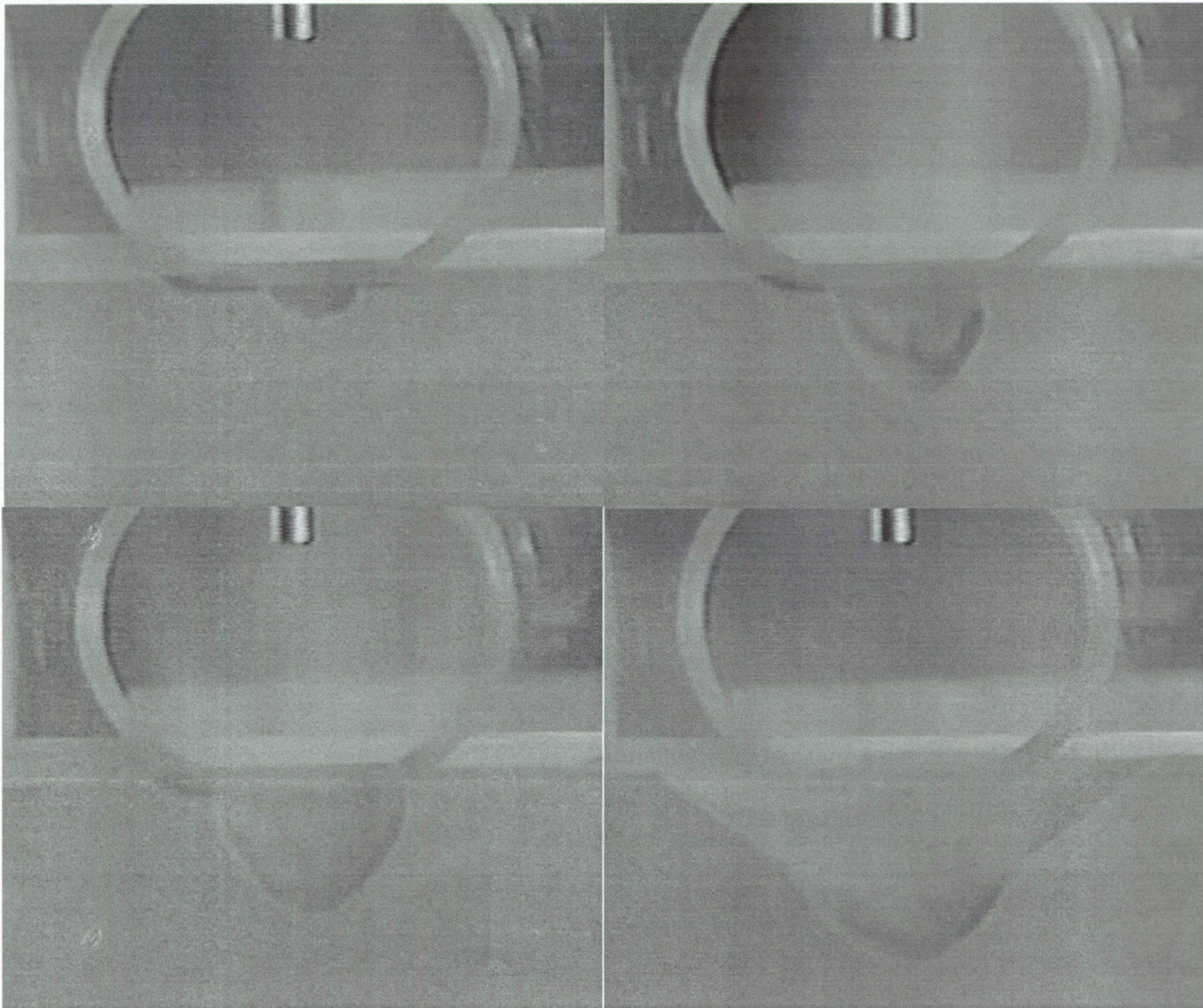


Viscous Erosion

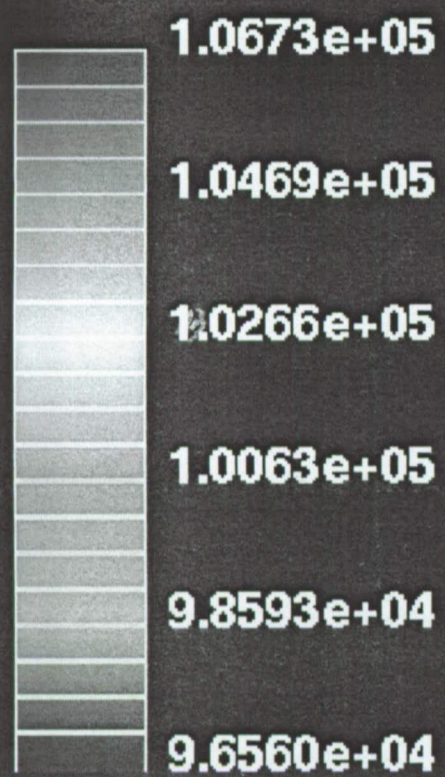


Movie of “slower” deep cratering

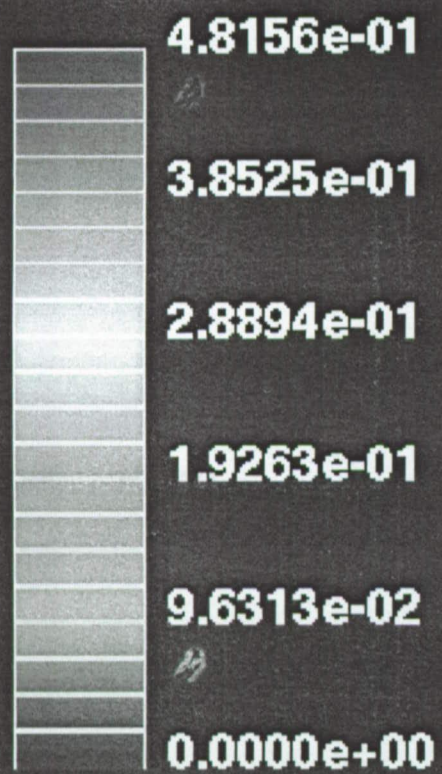


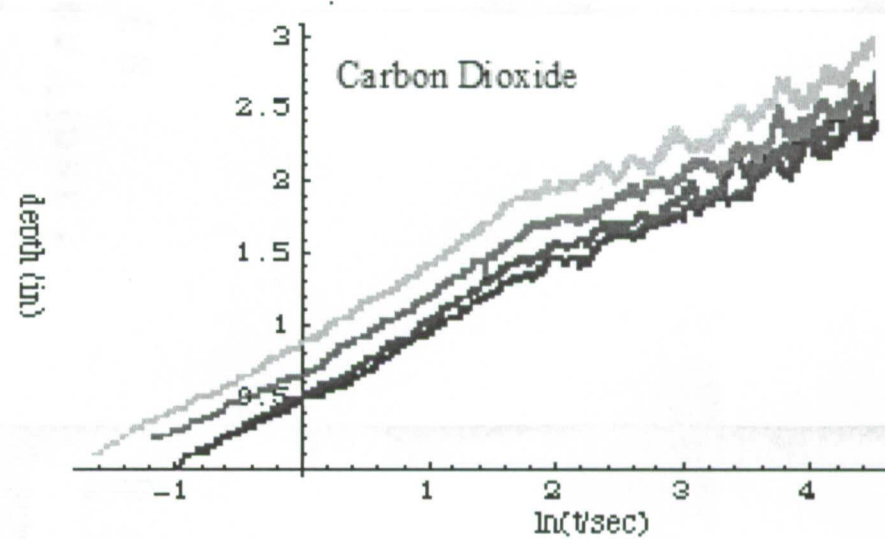
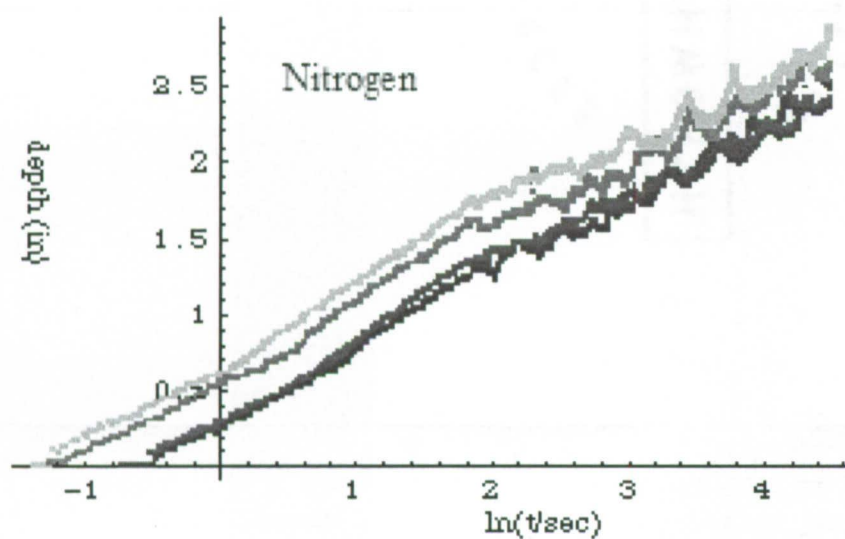
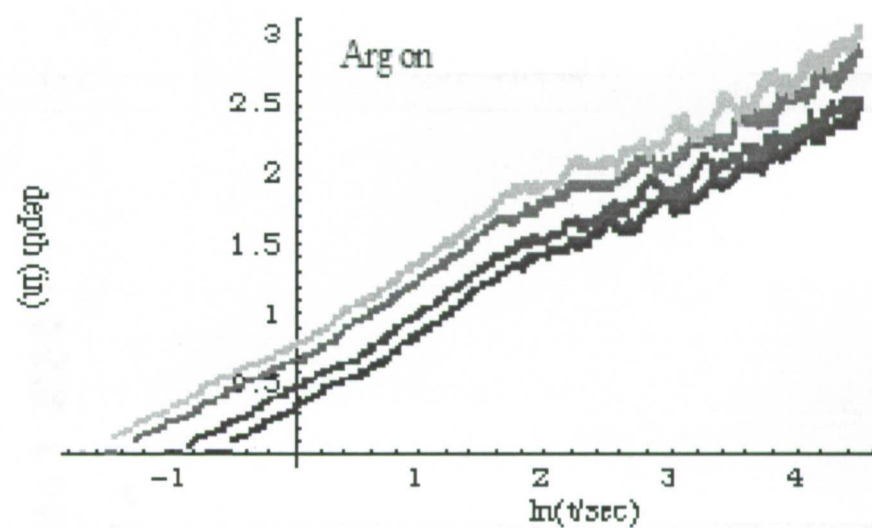
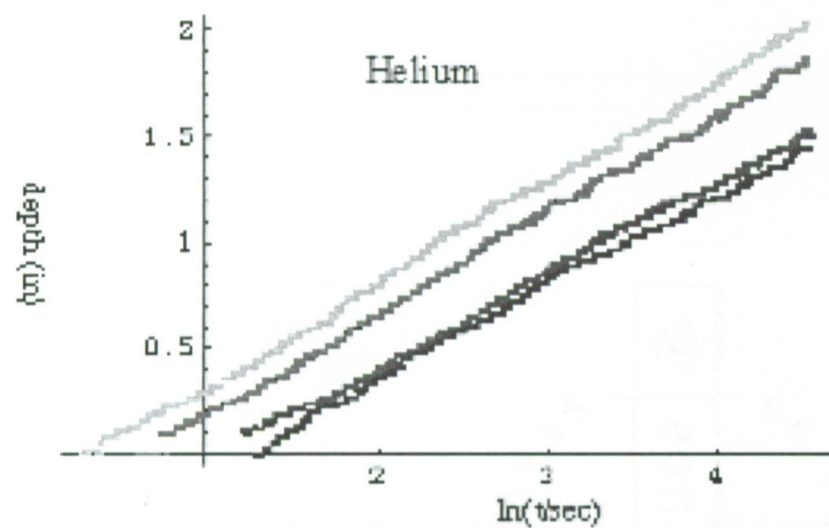


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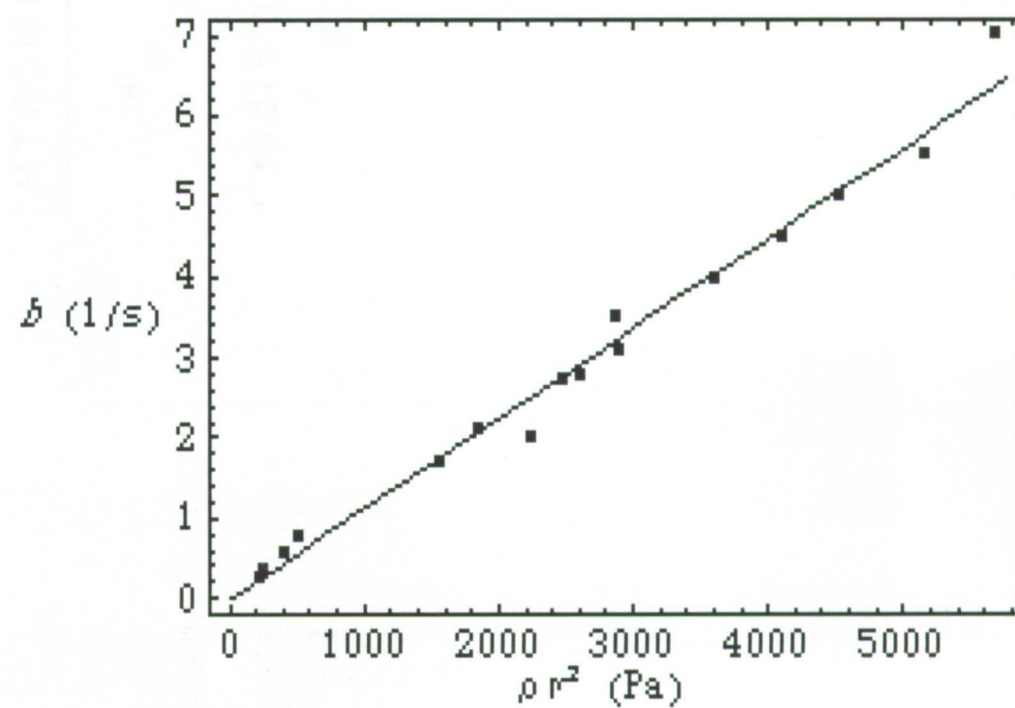
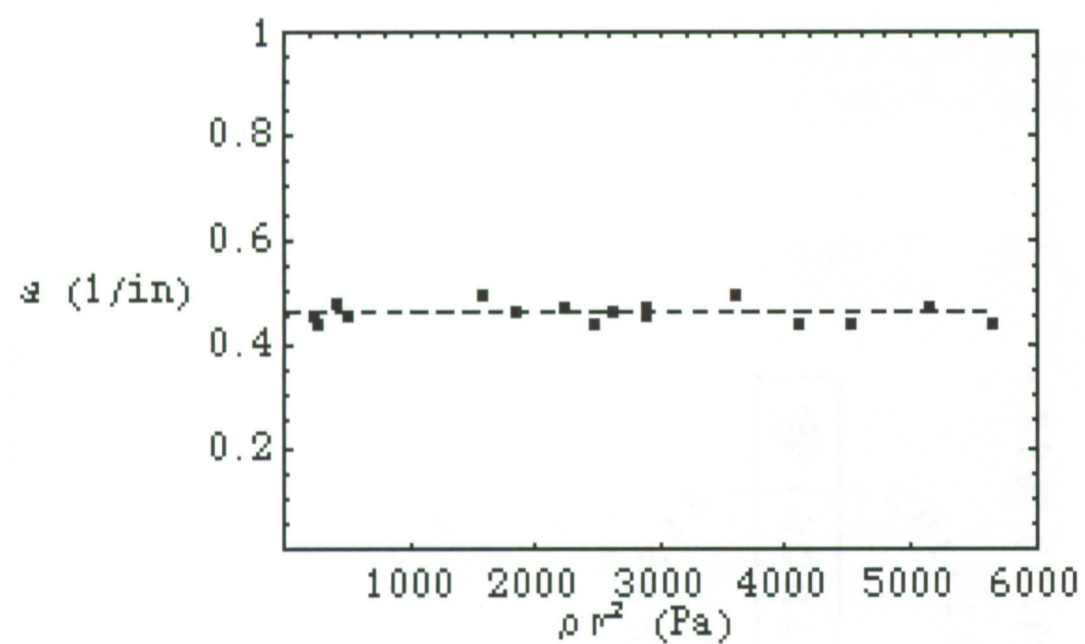
M





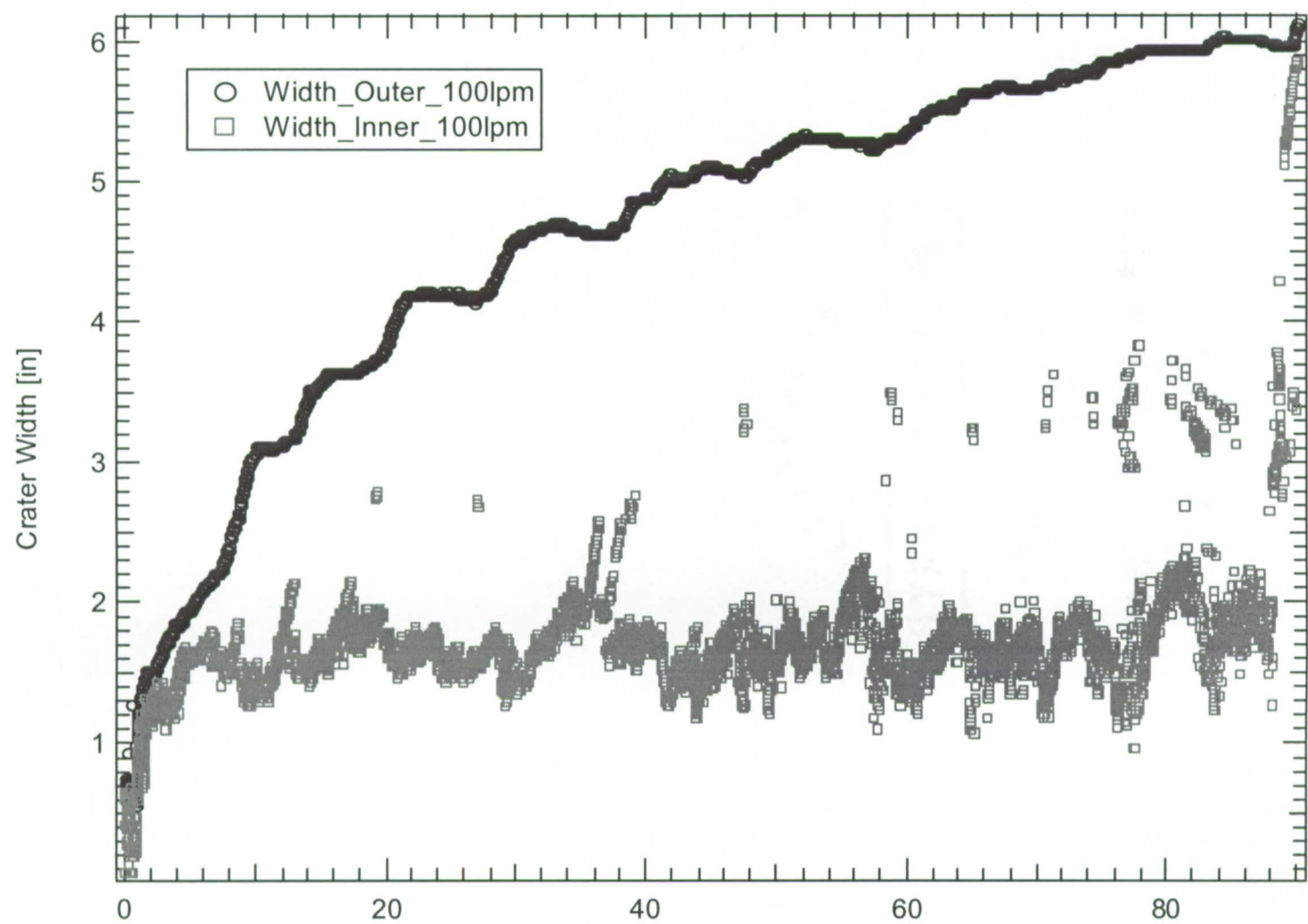
$$d / a = \ln[bt + 1], \quad t > 0$$

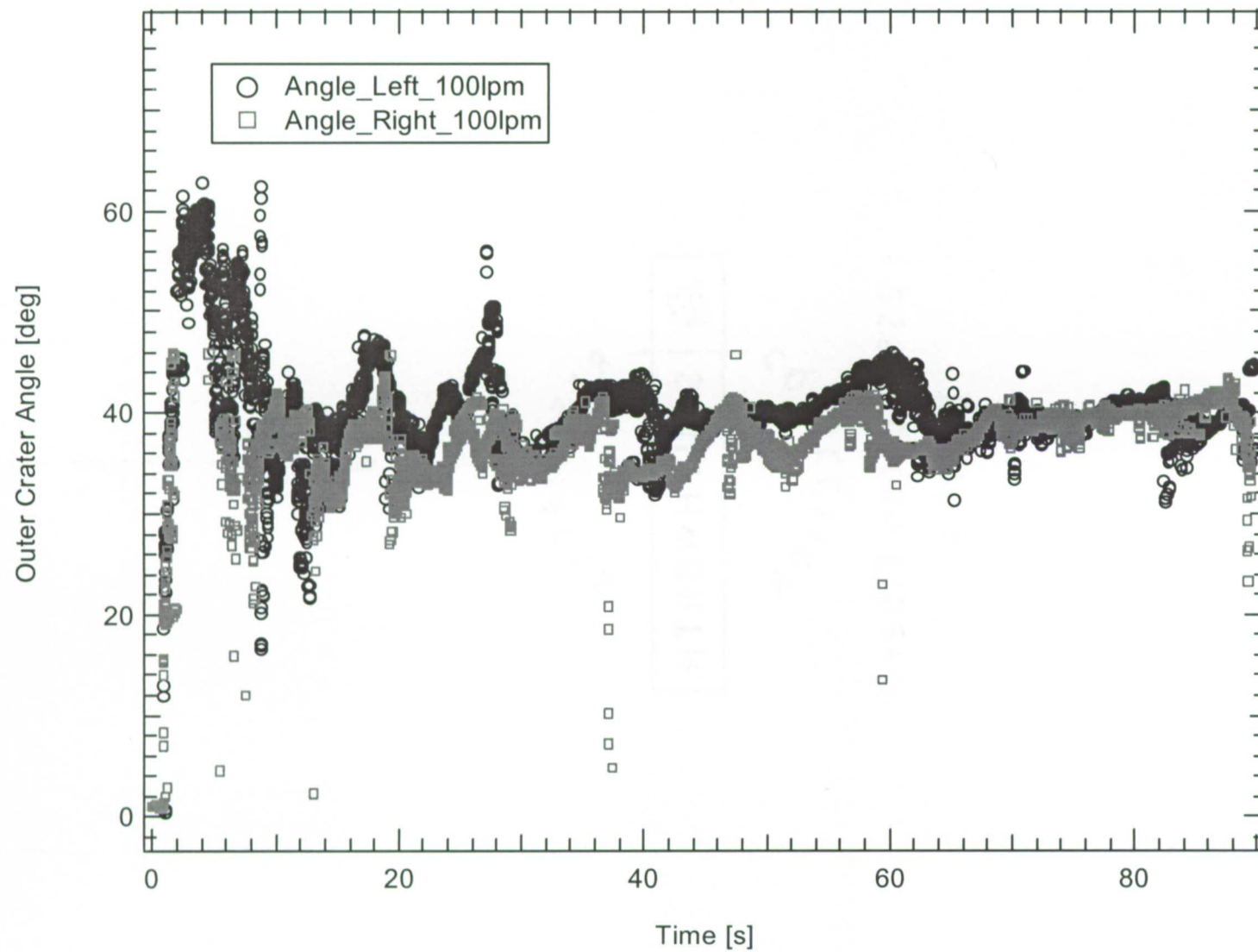
$$(\dot{d} / a) = be^{-(d/a)}, \quad t < t_0$$



$$d / a = \ln[bt + 1], \quad t > 0$$

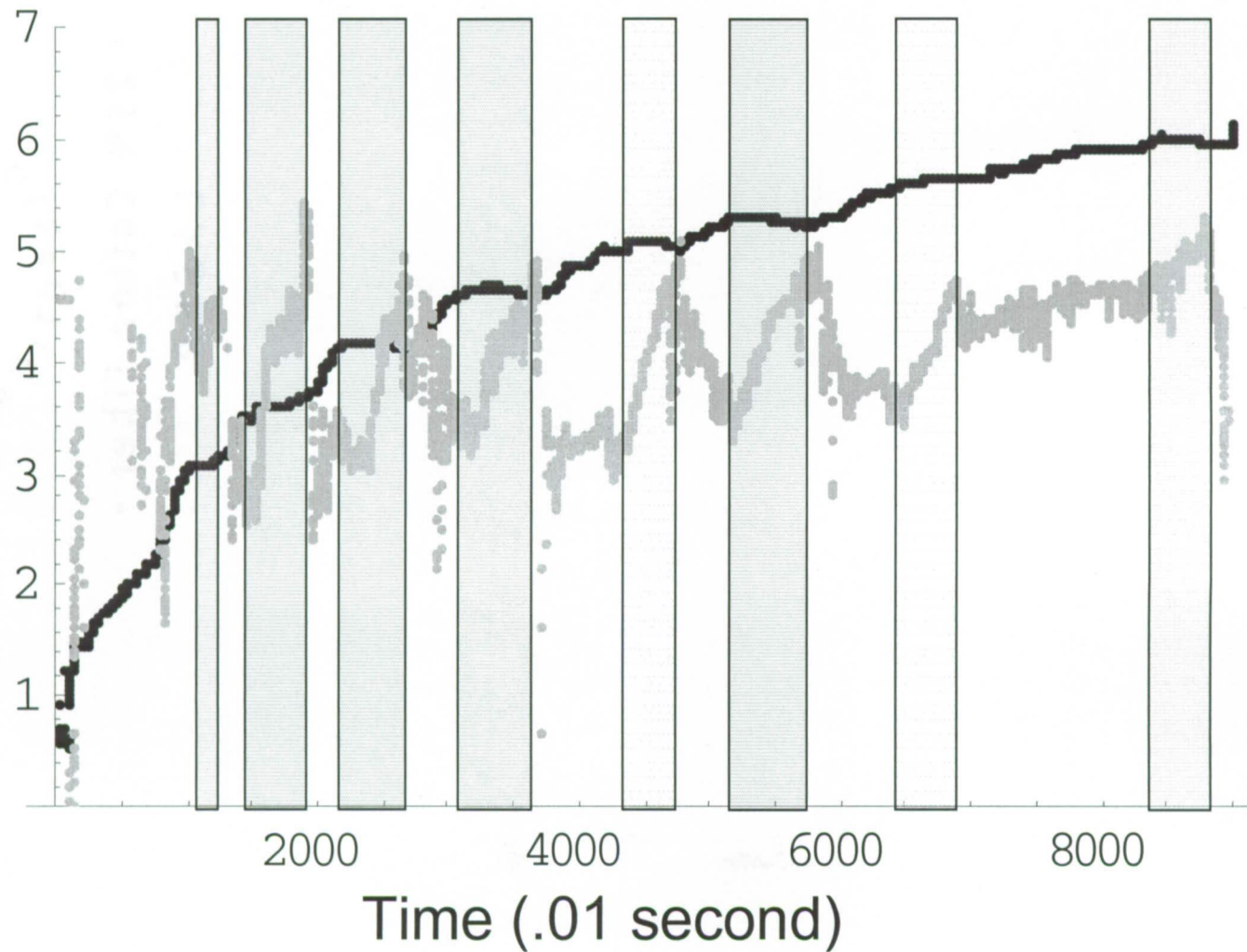
$$(\dot{d} / a) = be^{-(d/a)}, \quad t < t_0$$

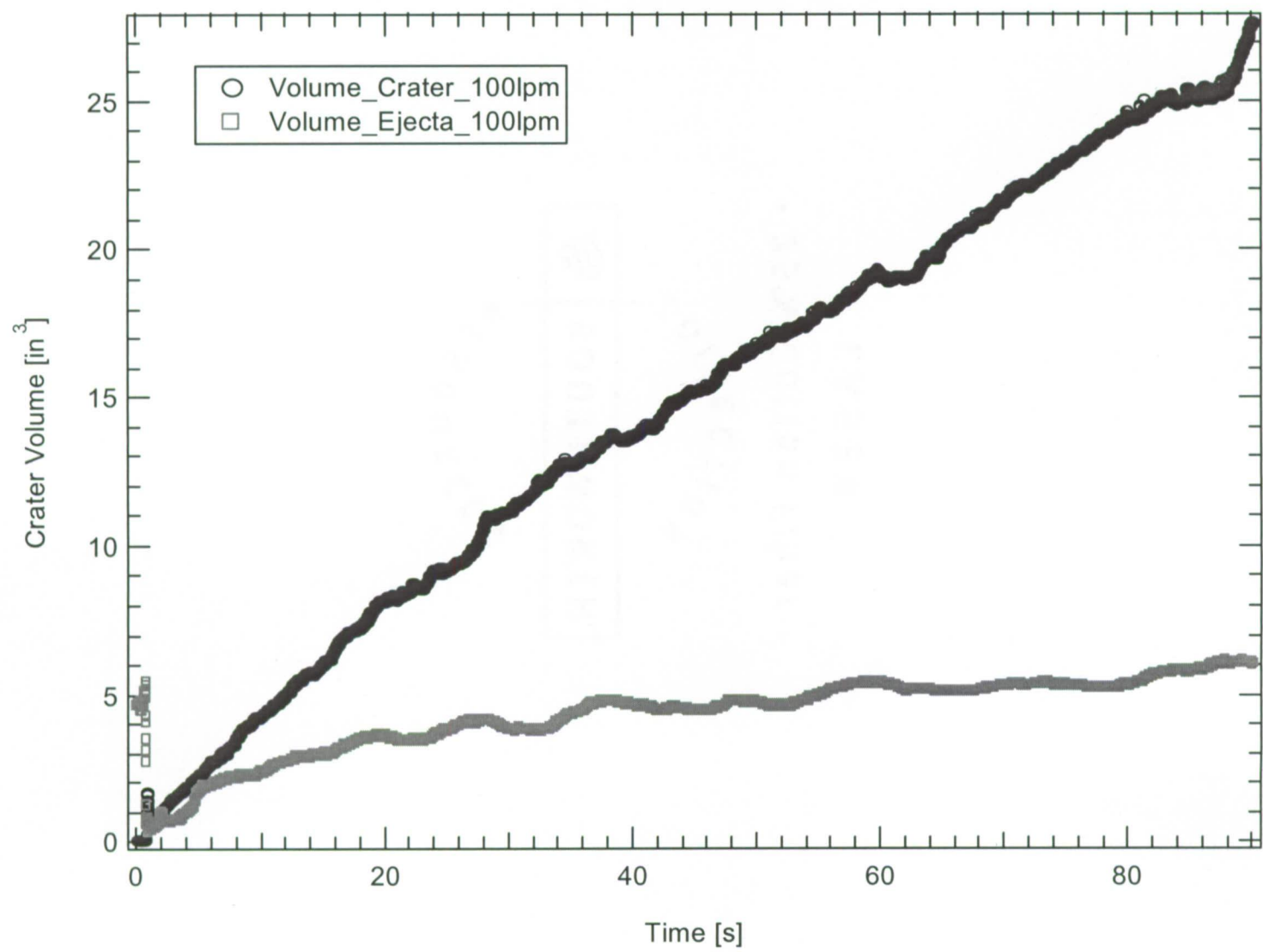




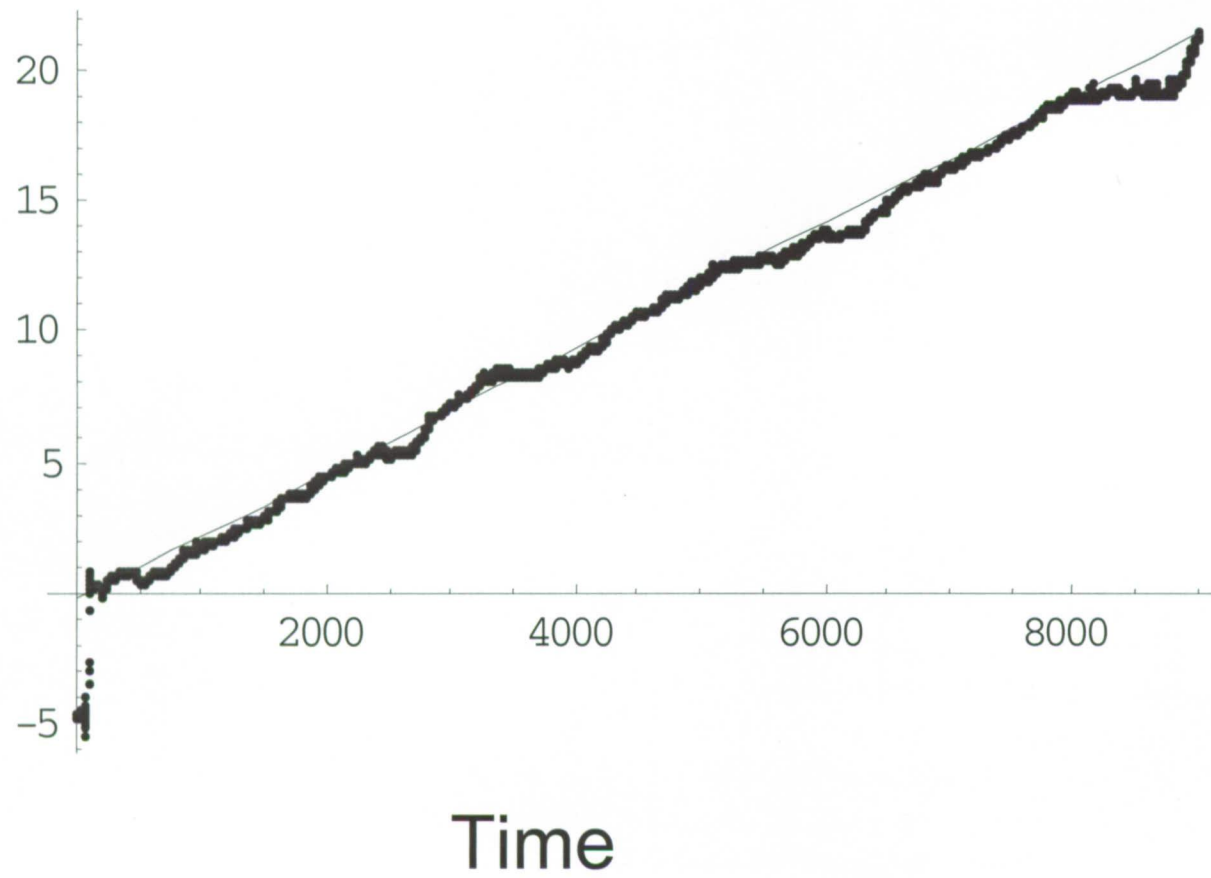
Green: Average slope angle

Black: Crater depth





Delta Volume



Recirculation Paths

